WHAT IS CLAIMED IS:

1. An avalanche photodetector (APD), comprising:

an absorption layer, which is made of a first semiconductor for absorbing an incident light and converting the incident light into carriers; wherein said absorption layer is graded heavily doped or heavily doped;

a multiplication layer, which is made of an undoped second semiconductor for multiplying currents by receiving and accumulating the carriers;

a field buffer layer, which is made of a third semiconductor sandwiched between the absorption layer and the multiplication layer for concentrating an electric field in the multiplication layer when a bias voltage is applied; and

a drift layer, which is made of an undoped fourth semiconductor sandwiched between the field buffer layer and the absorption layer for reducing capacitance.

2. The APD as claimed in claim 1, further comprising a first conduction layer and a second conduction layer, wherein the absorption layer is sandwiched between the first conduction layer and the drift layer and the multiplication layer is sandwiched between the second conduction layer and the field buffer layer.

3. The APD as claimed in claim 1, further comprising a first waveguide layer and a second waveguide layer, wherein the absorption layer is sandwiched between the first waveguide layer and the drift layer and the multiplication layer is sandwiched between the second waveguide

layer and the field buffer layer.

4. The APD as claimed in claim 1, further comprising a first multi-layer reflector set and a second layer of reflector set, wherein the absorption layer and the multiplication layer are sandwiched between the first multi-layer reflector set and the second layer of reflector set.

5. The APD as claimed in claim 2, further comprising a side wall hole relaxation layer to contact around the absorption layer and link the absorption layer and the first conduction layer for catching and relaxing hole of the absorption layer to the first conduction layer.

6. The APD as claimed in claim 1, wherein the absorption layer is superlattic with repeatedly interlaced multi-layer strain balance.

7. The APD as claimed in claim 1, wherein the absorption layer, the multiplication layer, the field buffer layer, the drift layer all are semiconductor of elements of group IV in periodic table or alloy semiconductor of elements of group IV in periodic table.

8. The APD as claimed in claim 1, wherein the absorption layer, the multiplication layer, the field buffer layer, the drift layer all are III-V based semiconductor or III-V based semiconductor alloy.

9. The APD as claimed in claim 1, wherein the absorption layer is p-type or n-type graded heavily doping or heavily doping SiGe, SiGeC, SiC/SiGe multi-layer superlattic, Si/SiGe multi-layer superlattic or Si/Ge quantum dot.

10. The APD as claimed in claim 1, wherein the multiplication layer is undoped Si layer, the drift layer is undoped Si layer, and the field buffer

layer is p-type or n-type heavily doped Si layer.

11. The APD as claimed in claim 1, wherein the absorption layer is p-type InGaAs, the drift layer is undoped InP, the field buffer layer is p-type graded bandgap InAlAs, and the multiplication layer is undoped InAlAs.

12. The APD as claimed in claim 4, wherein the first multi-layer reflector set and the second layer of reflector set are distributed Bragg reflector.

13. The APD as claimed in claim 5, wherein the hole relaxation layer is P^+-Ge or P^+-SiGe.

14. The APD as claimed in claim 3, wherein an incident direction of the incident light and an average propagation direction of the carriers are vertical or almost vertical.

15. The APD as claimed in claim 2, wherein an incident direction of the incident light and an average propagation direction of the carriers are parallel or almost parallel.

16. The APD as claimed in claim 4, wherein an incident direction of the incident light and an average propagation direction of the carriers are parallel or almost parallel.

17. The APD as claimed in claim 5, wherein an incident direction of the incident light and an average propagation direction of the carriers are parallel or almost parallel.

18. The APD as claimed in claim 1, wherein an APD including the absorption layer, the multiplication, the field buffer layer and the drift layer is formed by UHV-CVD, LP-CVD or MBE.

19. The APD as claimed in claim 1, wherein an APD including the absorption layer, the multiplication, the field buffer layer and the drift layer is formed on SOI (Silicon-On-Insulator) by UHV-CVD, LP-CVD or MBE.

20. The APD as claimed in claim 3, wherein the absorption layer, the multiplication layer and the waveguide cladding layer are integrated as an optical waveguide and its electrode structure forms an electrical transmission line.